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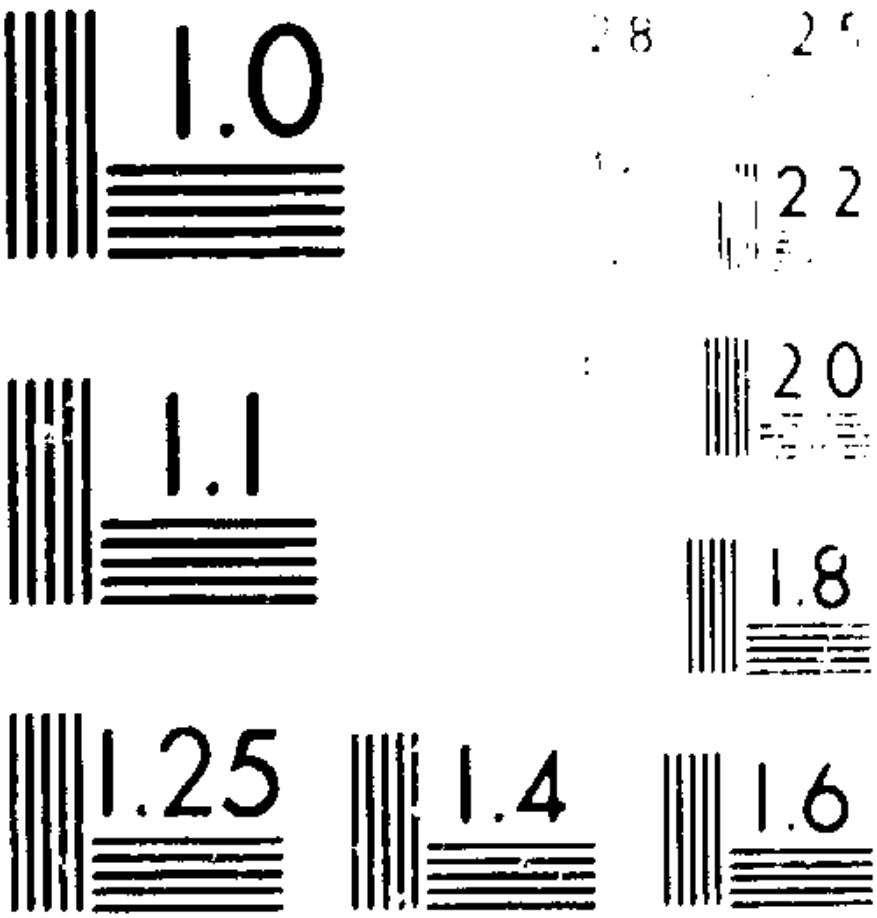
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Distr.
LIMITED
UNIDO/IOD.342
21 February 1980
English

→M. Dietrich

CLAY SAMPLES FROM PAPUA NEW GUINEA .

TECHNOLOGICAL EVALUATION *

UNIDO/Czechoslovakia Joint Programme
for International Co-operation in the Field of Ceramics,
Building Materials and Non-metallic Minerals Based Industries
in Pilsen - Czechoslovakia

By Miroslav Stockert
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I. ABSTRACT

This report gives the evaluation of prescribed properties of sixteen clay samples and one limestone sample from Papua New Guinea. The quantity of supplied samples was far below the amount, necessary for preliminary tests.

a) Six clays were indicated to be a possible basis for a brick manufacture. The objective of these tests was to specify one or more clay samples suitable for brick production. The best technological results have been found at sample IV. Sample V has shown good technological results, too.
Samples IV and V are usable for pottery production because of their light colour after firing and low drying and firing shrinkage.

b) Ten clays indicated as raw materials for pottery production have shown discouraging results in view of their use in ceramics due to cracking during drying. In case of utmost necessity, the use of these raw materials in small quantity added into pottery bodies containing kaolinitic clays without tendency to cracking would have yet to be verified.

c) Sample Burit 10 has been identified as a high-percentage limestone.

CONTENTS

II. INTRODUCTION

The clay samples from Papua New Guinea were delivered to the UNIDO/ Czechoslovakia Joint Programme by the UNIDO part of the Joint Committee on 15 May 1979.

The testing of samples was approved during the Second Session of the Joint Committee at Pilsen. (1)

Mr. Biering, UNIDO Officer, Vienna, handed over to the Chief Executive of the Joint Programme a copy of Memorandum to Mr. T. Unwin, Resident Representative, UNDP in Papua New Guinea from S. Dello Strologo, April 1979 in which the requirements for testing were specified. (2) The clays were divided into two groups.

Six clays were requested to be tested with the aim to identify one or more clays suitable for the brick manufacture.

The second group of ten clays was required to be tested for possible use in pottery production.

Following properties of clays were asked to be determined: (2)

a) maturing temperature
b) shrinkage percentage
c) absorption percentage
d) plasticity

Although the quantity of supplied samples was far below the necessary amounts, the determination of the required properties has been successfully accomplished.

III. CONCLUSIONS AND RECOMMENDATIONS

The two groups of clay samples from Papua New Guinea have been subjected to the testing.

1. Six clays for the brick manufacture have been tested with the following results:

   a) Out of them, clay sample No. IV has been found to be the best raw material for the brick manufacture by machine or hand moulding with maximum grain size of 1 to 3 mm and firing temperature of 950°C.

   b) Clay sample No. V has been determined to be the next suitable raw material for the brick manufacture by machine or hand moulding with maximum grain size of 1 to 3 mm and firing temperature of 950°C to 1000°C.

   c) Good technological results have been found at sample No. I. However, because of its low workability and lower plasticity, it would be suitable for machine production only.

   d) Clay sample Nos. II and III have shown fine cracks after firing and therefore, they cannot be recommended for the brick production.

   e) Clay sample No. VI has not been found to be suitable for the brick manufacture because of its low bending strength.

2. With regard to the above stated good results sample Nos. IV and V are recommended yet to be verified for their suitability in the brick production. Laboratory tests of both samples are recommended to be made with minimum quantity of 30,0 kg of each sample.

3. Sample Nos. IV and V are usable for pottery production because of their light colour after firing and low drying and firing shrinkage.

4. The clay samples for the pottery production have been tested with the following results:

   a) Except samples Burit 3 and Burit 6, cracks have occurred on small laboratory bricks as early as during the drying at a room temperature.

   b) Samples Burit 7 and 8 decayed to such an extent that they could not be tested.

   c) Small laboratory bricks made of all the samples have shown cracks and many of them have even decayed after firing.

5. The use of the tested ten clays in ceramics is risky due to their behaviour during drying and firing. In case of utmost necessity, the use of these raw materials, when added in small quantities into bodies containing kaolinitic clays, would have yet to be verified.

IV. TESTING AND EVALUATION OF PAPUA NEW GUINEA CLAY SAMPLES FOR BRICK MANUFACTURE

1. Description of Papua New Guinea Raw Clay Samples

Six samples of Papua New Guinea raw clays were handed over to the UNIDO/Czechoslovakia Joint Programme to identify one or more clays suitable for the brick manufacture. Samples were properly packed and marked I to VI. All the samples were evaluated visually at first, then tested by hydrochloric acid and found free from carbonates.

Visual evaluation of the samples:

Sample No. I - grey, very hard lumps, disintegration is very difficult -
weight of the sample - 0,60 kg

Sample No. II - highly plastic clay, light grey to ochre -
weight of the sample - 0,70 kg

Sample No. III - fairly plastic clay, light grey -
weight of the sample - 0,75 kg

Sample No. IV - lumpy, rather rigid clay, mixed red and grey clay -
weight of the sample - 0,55 kg

Sample No. V - ochre, plastic clay with light streaks, small hard lumps of dark grey clay were admixed -
weight of the sample - 1,10 kg

Sample No. VI - red-orange clay, mildly plastic -
weight of the sample - 0,95 kg

2. Determination of Wet Sieve Analysis

The rests on the 36 op/sq.cm. sieve and on the 4900 op/sq.cm. sieve have been determined by wet sieve analysis. The results are given in Table No. 1. (3)

A disintegration of sample No. I in water was very difficult and hot water had to be added for the purpose. The disintegration lasted four days.

None of all the six samples has any rests on the 36 op/sq.cm. sieve and the rests on the 4900 op/sq.cm. sieve vary from 0,0 % at sample No. I up to 4,2 % at sample No. V.

3. Firing Test of Raw Clay Samples

All the six samples of undressed clays were fired in an electric laboratory kiln at 1000°C temperature that was chosen as a middle temperature of a brickware firing range.

The run-up period to reach the 1000°C temperature was three and a half hours and the dwell on this temperature lasted for two hours.

Samples II and III have decayed after the firing test, the other samples have remained compact.

Colour of the samples after the firing:

No.	I	-	red
No.	II	-	red (pieces)
No.	III	-	pink (pieces)
No.	IV	-	rose with white streaks
No.	V	-	light red
No.	VI	-	dark red

The firing test has shown a tendency to cracking at sample Nos. II and III.

4. Green Properties of Small Laboratory Bricks

All six samples of Papua New Guinea clays were prepared at first into pieces of approximately 3 cm size and dried at a room temperature. Individual samples were then manually crushed, by means of a roller, to 1 mm maximum size and bodies were prepared by addition of water.

The workability of sample No. I was very low, the sample being extremely hard and resistant against crushing. The workability of the other samples was very good.

Small laboratory bricks were shaped manually in metal moulds. The dimensions of small bricks after moulding were 79 x 39 x 15 mm.

The small laboratory bricks were dried at a room temperature for three days at first, then they were dried in a laboratory drying chamber at 110°C for 24 hours. There were no drying troubles and no cracks were found after the drying.

Water of plasticity and drying shrinkage were then determined and the values thereof shown in Table No. 2. (3)

The values of water of plasticity varied from 21,94 % at sample No. I up to 48,2 % at sample No. III.

The lowest drying shrinkage of 5,4 % was found at sample No. I and the highest one at sample No. III.

5. Properties of Small Laboratory Bricks

Firing temperature is a very important technological point. A laboratory gradient kiln is often used to determine a suitable firing temperature by using small samples only.

Specimens in the shape of small beams were prepared from all the six samples, dried at a room temperature at first and then in a laboratory drying chamber at 110°C for 24 hours.

Individual small beams were put into a laboratory gradient kiln that enabled to fire particular parts of the small testing beams at different temperatures ranging from 800°C to 1000°C.

The samples were evaluated after firing in the laboratory gradient kiln and it was decided to fire small laboratory bricks at two temperatures, i.e. 950°C and 1020°C, in order to obtain a more complete picture about the dependence of firing shrinkage, water absorption and bending strength on the firing temperature.

The small laboratory bricks were properly dried and fired in a small laboratory electric kiln. The run-up period to reach the temperature of 950°C was seven and a half hours and the dwell on this temperature lasted for 2 hours.

The samples have the following colours and appearance after the firing:

Sample No.	I	-	light brown, no cracks
	II	-	red, fine cracks
	III	-	pink, cracks
	IV	-	rose, no cracks
	V	-	light red, no cracks
	VI	-	grey-red, no cracks

The firing process of small laboratory bricks at the temperature of 1020°C was done in the same way as at 950°C. The run-up period to reach the temperature of 1020°C was eight hours and the dwell on this temperature lasted for 2 hours.

The samples have the following colours and appearance after the firing:

Sample No.	I	-	brown-red, no cracks
	II	-	red, cracks
	III	-	pink, cracks
	IV	-	rose, no cracks
	V	-	light red, no cracks
	VI	-	grey-red, no cracks

Technological properties then have been determined - the values of firing shrinkage, water absorption and bending strength are given in Table No. 3. (3)

The values of firing shrinkage of the samples fired at the temperature of 950°C range from 0,0 % at sample No. IV to 1,35 % at samples No. V and No. VI. The values of the samples fired at 1020°C are higher with a minimum 2,10 % at sample No. I and a maximum 4,9 % at sample No. II.

The lowest water absorption of 14,76 % of the samples fired at 950°C has been found at sample No. I, the highest one, 27,82 %, at sample No. II.

The values of water absorption of all the six samples have decreased after firing at the temperature of 1020°C. The lowest water absorption has been again found at sample No. I, the highest one at sample No. VI.

The results of the bending strength when the values at 950°C and 1020°C are compared, are very interesting. The bending strength of the sample No. I has increased from 24,6 kp/sq.cm. at 950°C up to 100,2 kp/sq.cm. at 1020°C.

A substantial increase in the bending strength has also been found at sample No. II, i.e. from 9,2 kp/sq.cm. up to 22,71 kp/sq.cm. and at sample No. IV from 25,25 kp/sq.cm. up to 49,74 kp/sq.cm.

The bending strength of the other samples did not change much at the higher temperature.

V. TESTING AND EVALUATION OF PAPUA NEW GUINEA CLAY SAMPLES FOR RABAUL POTTERY PROJECT

1. Description of Clay Samples for Rabaul Pottery Project

Ten samples of Papua New Guinea clay samples were handed over to the UNIDO/Czechoslovakia Joint Programme and the determination of the following properties was required: (2)

a) maturing temperature
b) shrinkage percentage
c) absorption percentage
d) plasticity

Ten clay samples were marked: Burit 1, Burit 2, Burit 3, Burit 4, Burit 5A, Burit 5B, Burit 6, Burit 7, Burit 8 and Burit 9.

The sample marked Burit 10 was yellow-white, compact rock with a porous texture. It has been identified as a high-percentage limestone. The rest incoluble in hydrochloric acid is only 2,1 %.

Visual evaluation of the clay samples:

Burit 1: red-brown clay, with white and grey-red streaks - weight of the sample - 0,95 kg

Burit 2: red clay - weight of the sample - 0,80 kg

Burit 3: grey clay, sandy - weight of the sample - 1,10 kg

Burit 4: yellow ochre clay with white streaks - weight of the sample - 1,15 kg

Burit 5A: orange-brown clay - weight of the sample - 1,10 kg

Burit 5B: orange-brown clay - weight of the sample - 0,80 kg

Burit 6: very light yellow-grey clay, little plastic - weight of the sample - 1,05 kg

Burit 7: pale clay with brown streaks - weight of the sample - 1,10 kg

Burit 8: pale and light grey clay - weight of the sample - 1,0 kg

Burit 9: purple clay - weight of the sample - 0,80 kg

Burit 10: non-clay sample, compact, yellow-white rock with porous texture.

2. Determination of Wet Sieve Analysis

The rests on the 36 op/sq.cm. sieve and on the 4900 op/sq.cm. sieve have been determined by wet sieve analysis. The results are shown in Table No. 4. (3)

The 0,4 % rest on the 36 op/sq.cm. sieve was found at sample Burit 2 only, the other samples had no rest.

The lowest rest found on the 4900 op/sq.cm. sieve was 0,1 % at sample Burit 8 while the highest rests were found at samples Burit 6 (9,0 %) and Burit 3 (18,4 %).

The rest on the 36 op/sq.cm. sieve at sample Burit 2 contained grains up to 4mm size.

3. Determination of Plasticity Number

The plasticity number is determined by a method at which testing rolls prepared from the testing body with different moistures are deformed on special laboratory equipment. The plasticity number is calculated from the values of deformation and relating moistures. The higher the plasticity number, the better the plasticity of a tested clay.

The plasticity numbers found at all the ten samples are given in Table No. 5. (4)

The plasticity numbers vary from 32,7 at sample Burit 3 up to 80,3 at sample Burit 4.

For comparison: a good quality kaolin has a plasticity number ranging from 30 to 35.

4. Green Properties of Clay Samples for Rabaul Pottery Project

All the ten clay samples for the Rabaul Pottery Project were prepared at first into pieces of approximately 3 cm size and dried at a room temperature. Individual samples were then manually crushed by means of a roller to 1mm maximum size and bodies were prepared by addition of water.

Small laboratory bricks were shaped manually in metal moulds. Dimensions of the small bricks after moulding were 79 x 39 x 15 mm.

The small laboratory bricks were dried at the room temperature for four days and then in a laboratory drying chamber at 110°C for 24 hours.

Cracks occurred on the small laboratory bricks as early as during the drying at the room temperature. Burit 3 and Burit 6 were the only samples that had many cracks; samples Burit 7 and Burit 8 were decayed so that they could not be tested.

Water of plasticity and drying shrinkage have been determined and the values are given in Table No. 6.

High values of water of plasticity and of drying shrinkage indicate that the tested clays contain other clay minerals besides kaolin minerals.

5. Determination of Firing Shrinkage and Water Absorption

Properly dried small laboratory bricks prepared from the tested samples were fired in a laboratory electric kiln at three temperatures, i.e. 1050°C, 1150°C and 1250°C in order to determine their firing shrinkage, water absorption and maturing temperature under different technological conditions.

The description of small laboratory bricks after firing is given in Table No. 7.

The values of firing shrinkage and water absorption are shown in Table No. 8.

The firing shrinkage could not be determined completely at all the ten clay samples because of cracks which occurred in the specimens after drying and firing. Samples marked Burit 5B, Burit 7, Burit 8 and Burit 9 decayed after firing. It was impossible to conduct any test of these samples at all.

The values of water absorption show that maturing temperature at 1050°C has been reached at sample Burit 8.

Samples Burit 2 with water absorption of 1,81 %, Burit 5B with water absorption of 1,12 %, Burit 7 with water absorption of 1,31 % have reached the maturing temperature just beyond 1150°C.

Water absorption value of sample Burit 5A shows that the maturing temperature of this sample is 1150-1160°C.

Samples Burit 1, Burit 3, Burit 4, Burit 6 and Burit 9 have the maturing temperature over 1250°C.

Firing of samples at higher temperatures could not be performed for insufficient quantity of clay samples. (5)

VI. SUMMARY

All the sixteen clay samples from Papua New Guinea and one sample of limestone were tested and evaluated by the UNIDO/Czechoslovakia Joint Programme. The quantity of individual samples submitted for testing was not sufficient. (5) Therefore, the determinations of the plasticity number and of the maturing temperature are to be considered as informative only.

a) Six Clay Samples for Brick Manufacture

All the six clay samples were evaluated visually and tested by hydrochloric acid for the presence of carbonates. This test has shown negative results.

The wet sieve analysis was carried out at all the six samples. There were no rests on the 36 op/sq.cm. sieve and a small rest on the 4900 op/sq. cm. sieve amounting to 4,2 % maximum at sample No. V.

Firing test of all the undressed six samples was conducted at the temperature of 1000°C. Samples No. II and No. III decayed. When small laboratory bricks were fired at the temperature of 950°C and 1020°C, cracks occurred on those made of the same clay samples.

Small laboratory bricks were shaped from all the six samples and water of plasticity, drying shrinkage, firing shrinkage, water absorption and bending strength were determined.

The results show that sample No. IV is the most suitable clay for brick manufacture. Very good results have been also reached with sample No. I, but, due to its hardness and very low workability, it may come into question for machine body preparation only.

Good results have been found at sample No. V, too.

Sample Nos. IV and V may be recommended to be tested for possible use in the pottery production. They show light colours after firing, low drying and firing shrinkage and no cracks have been found after drying and firing.

b) Ten Clay Samples for Rabaul Pottery Project

All the ten clay samples were evaluated visually and tested by hydrochloric acid for the presence of carbonates. This test was negative.

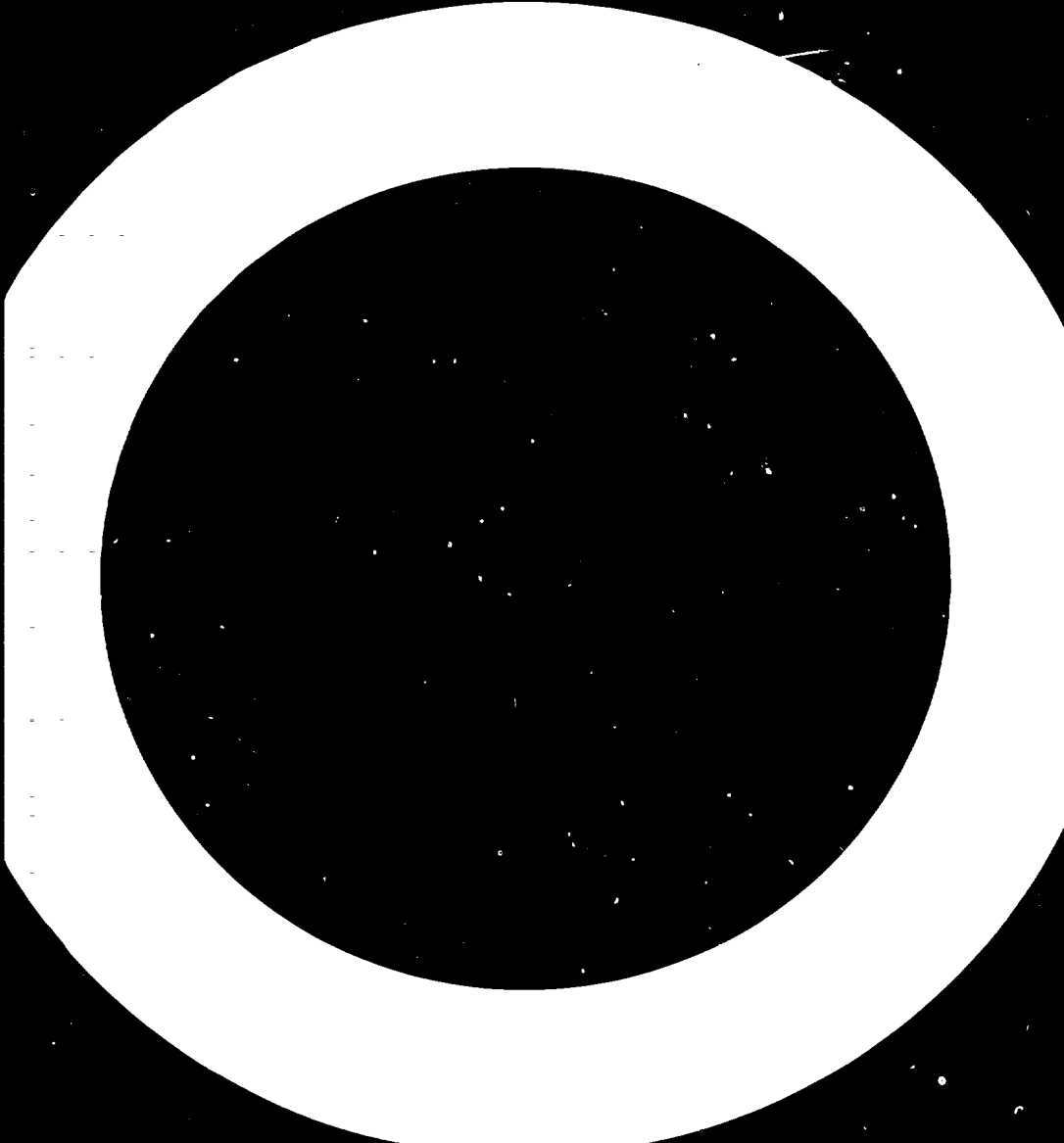
Wet sieve analysis was carried out at all the ten clay samples. Rather high rests on the 4900 op/sq.cm. sieve have been found at sample Burit 6 - 9,0 % and at sample Burit 3 - 18,4 %.

Small laboratory bricks were shaped from all the ten clay samples and water of plasticity, drying shrinkage, firing shrinkage, water absorption and maturing temperature were determined. Plasticity number has been also determined, due to the insufficient amount of individual clay samples; however, the values are informative only.

Due to the presence of other than kaolin minerals, the alarming cracking occurred during the drying. Moreover, samples Burit 5B, Burit 7, Burit 8 and Burit 9 decayed after the firing.

The tested clays could be used in the pottery production in small quantities only as addition to bodies containing clays without tendency to cracking, but it would have yet to be varified.

c) Sample Burit 10 has been identified as a high-percentage limestone. The rest insoluble in hydrochloric acid amounted to 2,1 % only.



VII. A P P E N D I X E S

1. P A P U A N E W G U I N E A

Table Nos. 1 - 8

Reference (3 - 4)

Research Institute for Ceramics
Refractories and Raw Materials

Horní Bříza

Report Nos. Vý 569/1979, 605/1979

Table No. 1

Papua New Guinea: Wet Sieve Analyses of Six Clay Samples for Brick Manufacture
Rest on the Sieve 36 op/sq.cm. and on the Sieve 4900 op/sq.cm.

Sample	I.	II.	III.	IV.	V.	VI.
Rest on the sieve 36 op/sq.cm. (%)	0	0	0	0	0	0
Rest on the sieve 4900 op/sq.cm. (%)	0	0,4	2,0	2,2	4,2	2,6

Reference (3): Research Institute for Ceramics, Refractories and Raw Materials, Horní Bříza
Report No. Vý 569/1979

Table No. 2

Papua New Guinea: Water of Plasticity and Drying Shrinkage of Six Clay Samples for Brick Manufacture

Sample	I.	II.	III.	IV.	V.	VI.
Water of plasticity (%)	21,94	47,33	48,20	26,59	37,14	35,00
Drying shrinkage (%)	5,4	10,3	11,1	6,2	8,7	5,9

Reference (3): Research Institute for Ceramics, Refractories and Raw Materials, Horní Bříza Report No. Vý 569/1979

Table No. 3

Papua New Guinea: Firing Shrinkage, Water Absorption and Bending Strength of Six Clay Samples for Brick Manufacture

	Fired at 950°C			Fired at 1020°C		
Sample	Firing shrinkage (%)	Water absorption (%)	Bending strength kp/sq.cm.	Firing shrinkage (%)	Water absorption (%)	Bending strength kp/sq.cm.
I.	0,2	14,74	24,6	2,1	10,38	100.2
II. +	1,1	27,82	9,2	4,9	20,74	22,70
III. +	0,6	23,31	16,0	3,6	17,65	17,52
IV.	0	20,36	25,25	2,4	18,14	49,74
V.	1,35	24,70	20,94	4,2	19,43	21,66
VI.	1,35	25,34	11,49	3,7	22,04	9,13

+ cracks after firing at both temperatures

Reference (3): Research Institute for Ceramics, Refractories and Raw Materials, Horní Bříza
Report No. Vý 569/1979

Table No. 4

Papua New Guinea: Wet Sieve Analyses of Ten Clay Samples for Rabaul Pottery Project
Rest on the Sieve 36 op/sq.cm. and on the Sieve 4900 op/sq.cm.

Sample	B1	B2	B3	B4	B5A	B5B	B6	B7	B8	B9
Rest on the sieve 36 op/sq.cm. (%)	0	0,4	0	0	0	0	0	0	0	0
Rest on the sieve 4900 op/sq.cm. (%)	4,0	1,0	18,4	1,8	1,0	1,0	9,0	0,4	0,1	4,0

Reference (3): Research Institute for Ceramics, Refractories and Raw Materials, Horní Bříza
Report No. Vý 569/1979

Table No. 5

Papua New Guinea: Plasticity Number of Ten Clay Samples for Rabaul Pottery Project

Sample	B1	B2	B3	B4	B5A	B5B	B6	B7	B8	B9
Plasticity number	54,2	62,3	32,7	80,3	39,6	39,5	36,2	38,3	40,6	40,6

Remarks: The results can be considered as informative only. Method of plasticity number determination requires 1,5 kg of sample at least. Total weight of individual samples was approx. 1,0 kg. Therefore, 0,25 kg only could have been used for this test.

Reference (4): Research Institute for Ceramics, Refractories and Raw Materials, Horní Bříza Report No. 605/79

Table No. 6

Papua New Guinea: Water of Plasticity and Drying Shrinkage of Ten Clay Samples for Rabaul Pottery Project

Sample	B1+	B2+	B3	B4+	B5A+	B5B+	B6	B7++	B8++	B9+
Water of plasticity (%)	50,38	58,70	45,24	32,45	50,42	47,43	38,03	N.D.	N.D.	48,14
Drying shrinkage (%)	15,3	15,7	14,5	11,2	11,8	12,4	10,7	N.D.	N.D.	17,2

\+ cracks after drying

++ decayed after drying

N.D. not determined - could not be tested

Reference (3): Research Institute for Ceramics, Refractories and Raw Materials, Horní Bříza Report No. Vý 569/1979

Table No. 7

Papua New Guinea: Description of Small Laboratory Bricks Fired at 1050°C, 1150°C and 1250°C Temperatures

Rabaul Pottery Project

	Firing temperature 1050°C		Firing temperature 1150°C		Firing temperature 1250°C	
Sample	Colour	Appearance	Colour	Appearance	Colour	Appearance
Burit 1	red	cracks	dark red	cracks	dark red	cracks
Burit 2	red	cracks	dark red	cracks	dark red	cracks
Burit 3	light red	fine cracks	red	fine cracks	dark brown	fine cracks
Burit 4	light red	cracks	dark red	cracks	red brown	cracks
Burit 5A	dark red	cracks	brown red	cracks	dark red	cracks
Burit 5B	dark red	cracks	brown red	decayed	dark red	decayed
Burit 6	orange red	cracks	red	cracks	brown red	cracks
Burit 7	dark red	decayed	dark red	decayed	violet red	decayed
Burit 8	dark red	decayed	dark red	decayed	violet red	decayed
Burit 9	light brown	decayed	light brown	decayed	dark brown	decayed

Reference (3): Research Institute for Ceramics, Refractories and Raw Materials, Horní Bříza
Report No. Vý 569/1979

Table No. 8

Papua New Guinea: Firing Shrinkage and Water Absorption of Small Laboratory Fired Bricks. Rabaul Pottery Project

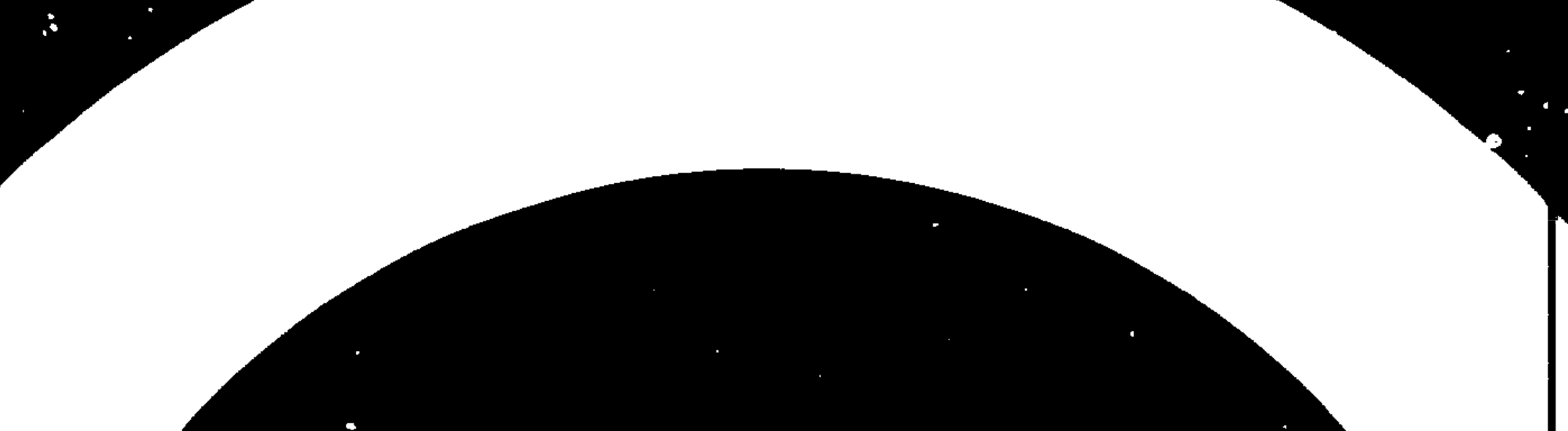
Sample	Firing shrinkage (%)			Water absorption (%)		
	1050°C	1150°C	1250°C	1050°C	1150°C	1250°C
Burit 1+	7,0	5,8	6,8	8,33	6,47	4,41
Burit 2+	8,4	10,4	11,0	9,92	1,81	1,85
Burit 3+	3,2	3,0	6,5	14,11	12,23	4,42
Burit 4+	5,9	6,4	4,0	5,43	3,43	5,02
Burit 5A+	12,3	14,4	14,4	5,26	2,10	1,35
Burit 5B+	14,00	N.D.++	N.D.++	5,18	1,12	1,27
Burit 6+	4,4	4,0	8,3	19,48	19,30	7,48
Burit 7++	N.D.	N.D.	N.D.	3,25	1,31	4,23
Burit 8++	N.D.	N.D.	N.D.	1,87	3,02	3,18
Burit 9++	N.D.	N.D.	N.D.	3,57	3,63	2,40

+ cracks after firing

++ decayed after firing

N.D. not determined, could not be tested

Reference (3): Research Institute for Ceramics, Refractories and Raw Materials, Horní Bříza Report No. Vý 569/1979



2. P A P U A N E W G U I N E A

Exhibit Nos. 1 - 6

EXHIBIT No. 1

PAPUA NEW GUINEA

Small Laboratory Bricks Dried at 110°C

Clay Samples for Brick Manufacture

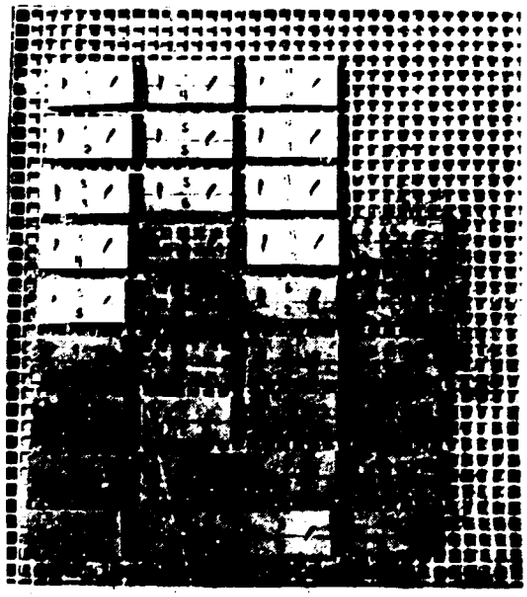


EXHIBIT No. 2

PAPUA NEW GUINEA

Small Laboratory Bricks Dried at 110°C

Clay Samples for Rabaul Pottery Project

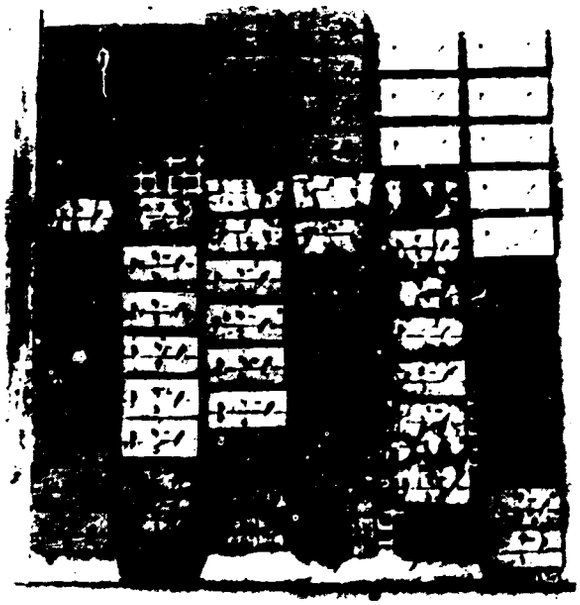


EXHIBIT No. 3

PAPUA NEW GUINEA

Small Laboratory Bricks Fired at 950°C

Clay Samples for Brick Manufacture

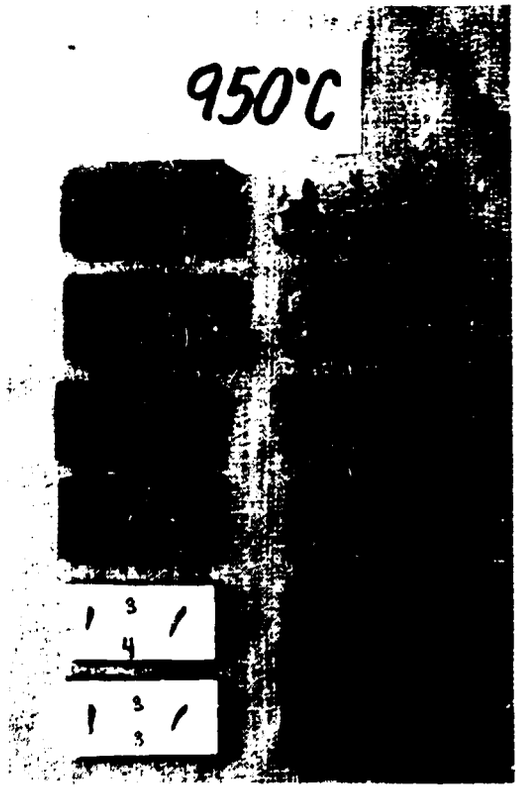


EXHIBIT No. 4

PAPUA NEW GUINEA

Small Laboratory Bricks Fired at 1050°C

Clay Samples for Rabaul Pottery Project

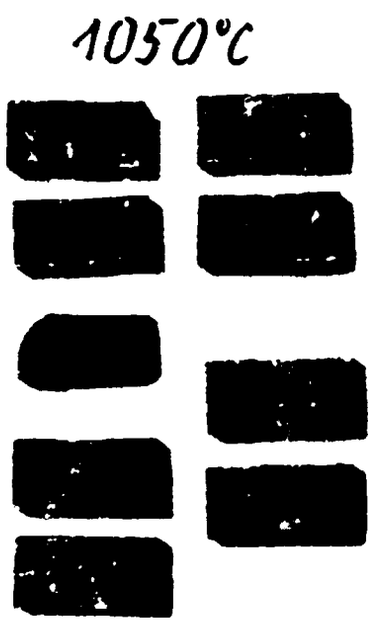


EXHIBIT No. 5

PAPUA NEW GUINEA

Small Laboratory Bricks Fired at 1150°C

Clay Samples for Rabaul Pottery Project

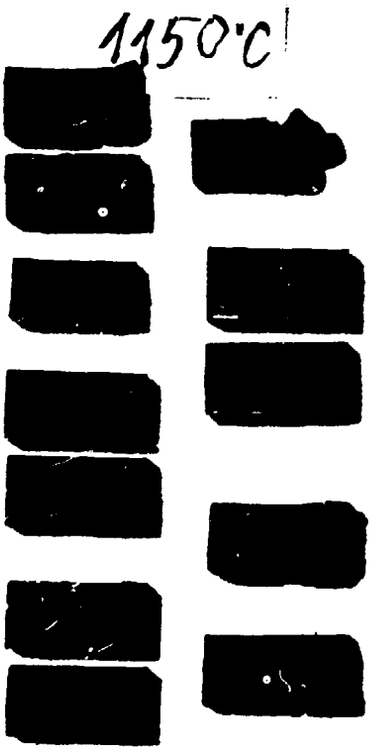
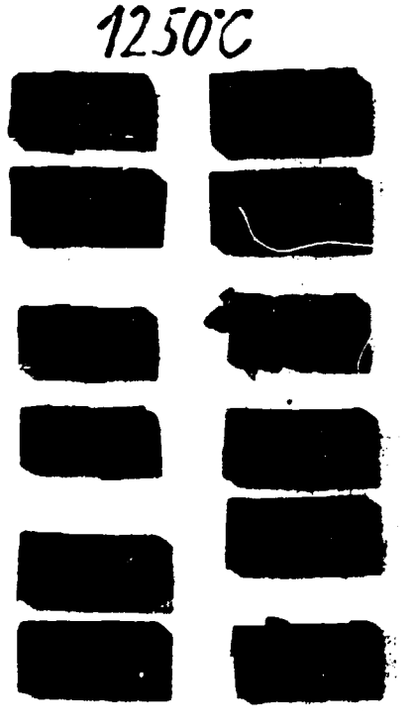


EXHIBIT No. 6

PAPUA NEW GUINEA

Small Laboratory Bricks Fired at 1250°C

Clay Samples for Rabaul Pottery Project



VIII. REFERENCES

1. Minutes of the Second Session of the Joint Committee of the UNIDO/Czechoslovakia Joint Programme for International Co-operation in the Field of Ceramics, Building Materials and Non-metallic Minerals Based Industries, held in the UNIDO/Czechoslovakia Joint Programme at Pilsen on 14 through 16 May 1979.

2. Memorandum to Mr. T. Unwin, Resident Representative, UNDP in Papua New Guinea from S. Dello Strologo, April 1979.

3. Research Institute for Ceramics, Refractories and Raw Materials, Horní Bříza, Report No. Vý 569/1979.

4. Research Institute for Ceramics, Refractories and Raw Materials, Horní Bříza, Report No. Vý 605/1979.

5. Z. Engelthaler, M. Stockert: Ceramic Raw Material Testing, UNIDO/Czechoslovakia Joint Programme for International Co-operation in the Field of Ceramics, Building Materials and Non-metallic Minerals Based Industries, Pilsen, May 1979.